Canadian Grain Commission
Commission canadienne des grains

Grain
Research
Laboratory

Quality of Western Canadian Malting Barley 1989

Canada

Quality of Western Canadian Malting Barley

1989

D.E. LaBerge
Head, Malting Barley Applied Research

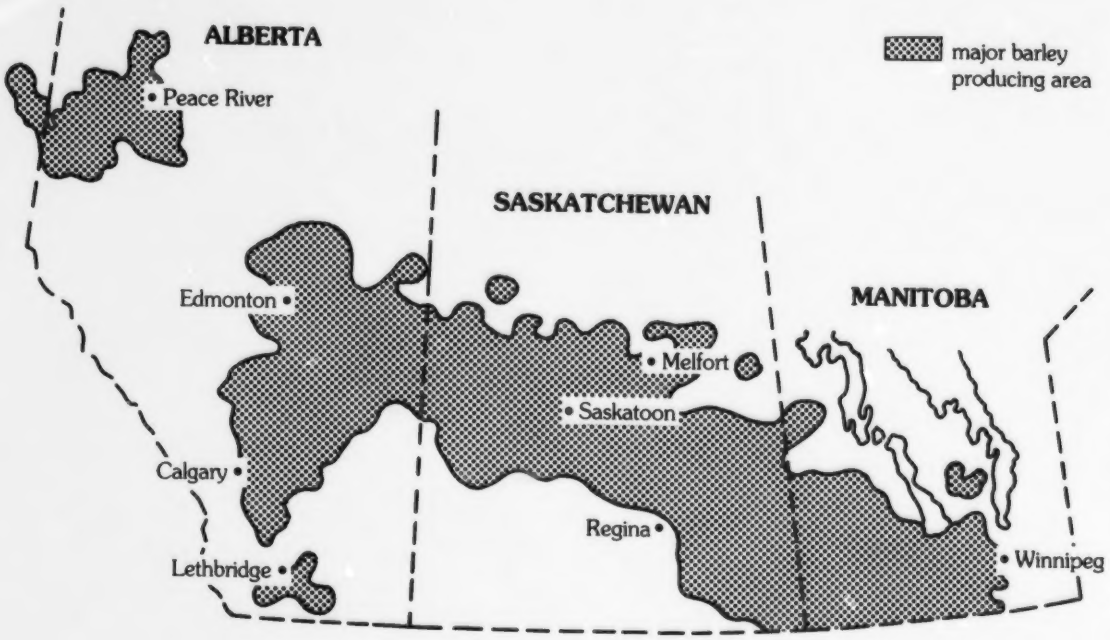
K.H. Tipples
Director

Crop Bulletin No. 180

Grain Research Laboratory
Canadian Grain Commission
1404-303 Main Street
Winnipeg, Manitoba
R3C 3G8

90-01438/

Figure 1: Major Barley Producing Area in Canada



Introduction

This is the first edition of a new series of crop bulletins to describe the quality of malting barley grown in the three prairie provinces of Western Canada. Barley is also the major grain crop grown in Western Canada as a coarse grain for livestock feed, and another crop bulletin entitled *Quality of Western Canadian Feed Barley • 1989* is available upon request.

Barley growers in the Canadian Prairies have demonstrated a preference for growing malting barley varieties. During the past 45 crop years, malting barley was grown on an average of 70% of the total barley area (Fig. 2). Malting barley is a dual purpose barley; if production cannot be sold at a premium for malting and brewing, then it is utilized as livestock feed. Registered feed barley varieties are not suitable for malting and brewing and, as a result, can only be used for livestock feed.

During recent years, there have been significant changes in the production patterns of six-rowed and two-rowed malting barley varieties in the prairie provinces (Fig. 3). Traditionally, six-rowed malting barley varieties were dominant, reflecting the preference of Canadian brewers to utilize six-rowed malt. However, with the development of two-rowed malting barley varieties with wider adaptation to growing conditions in the Prairies, two-rowed malting barley varieties now dominate the malting barley growing areas of Western Canada. As a result, domestic brewers now use much more two-rowed barley in their malt blends which, in turn, will further encourage barley growers to maximize production of two-rowed malting barley cultivars.

Figure 2: Trends in Production of Malting Barley Varieties and Feed Barley Varieties in the Prairie Provinces (1945 to 1989)

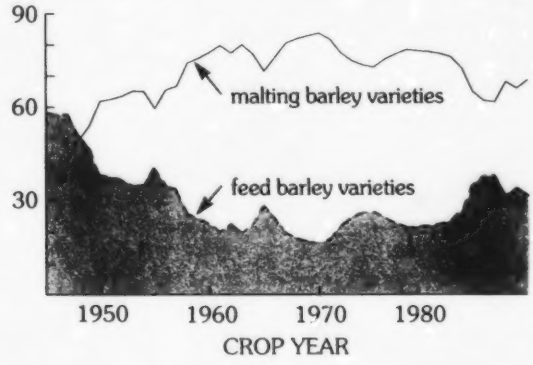
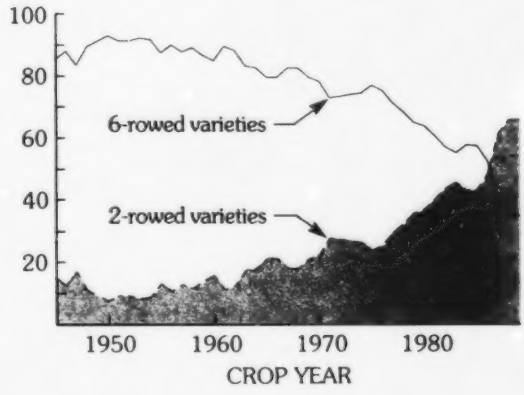


Figure 3: Trends in Malting Barley Production in the Prairie Provinces (1945 to 1989)



Review of Weather and Harvesting

The outlook for barley at seeding was rather mixed. In Manitoba and Saskatchewan, soil moisture reserves were very limited following dry weather in 1988 and a dry spring in 1989. In Alberta, particularly further west, reserves were generally much better and there was less concern over drought.

May was quite warm and dry in Manitoba, and virtually all of the barley was sown by the end of the month. Progress in Saskatchewan was also good, but cool conditions in Alberta caused seeding delays - with only 65% planted by that time.

June weather eased drought fears in many areas as rains were widespread. They were particularly heavy in Manitoba, east-central and south-central Saskatchewan and in much of Alberta (though with some exceptions in the Peace River region).

The optimism over production prospects at the end of June faded during July, as Saskatchewan and Manitoba endured a hot, dry month and the long-term lack of moisture came into play. With little rainfall and hot weather persisting into August, conditions for grain filling were well below optimum, and yields inevitably suffered. The late season drought was also responsible for relatively low barley test weight. In Alberta, too, an extended warm, dry spell from mid-July to mid-August reduced yield expectations, but losses were also the result of lodging and various disease problems.

Harvest conditions varied considerably across the Prairies. Due to dry weather, Manitoba's crop was already 70% harvested by the end of August, while Saskatchewan was no more than 50% complete and Alberta less than 10%. Frequent rains in late August and early September slowed harvest progress in most areas, and combining didn't recommence until mid-September when warm, drier weather returned. At the end of September, the Manitoba harvest was complete, Saskatchewan was almost done, and Alberta still had about 25% remaining to be combined. The rainfall during the harvest period caused a substantial amount of weathering in the harvested barley.

Production Estimates

Estimates of total barley production in the prairie provinces during 1989 and 1988 are presented in Table 1. Total barley production in 1989 is estimated to be 10 647 000 tonnes which is an 18.4% increase over 1988 - due almost entirely to a 14.7% increase in seeded area.

Distribution estimates of malting and feed barley varieties grown in the prairie provinces are presented in Table 2. These data indicate that the area seeded to malting varieties increased from 66.5% of the total barley area in 1988 to 69.6% in 1989.

Comparisons of malting barley production in 1988 and 1989 are presented in Table 3. Malting barley production increased by 25.3% from 5.7 million tonnes in 1988 to about 7.2 million tonnes in 1989, partially as a result, as indicated earlier, of the increase in the area seeded to malting varieties.

Harrington is the most popular two-rowed variety grown in Alberta and Saskatchewan, occupying over 60% of the malting barley area in these provinces (Table 4). Argyle and Bonanza are six-rowed varieties grown widely in Manitoba and accounting for 85% of the malting barley area. Harrington lacks the disease resistance required for malting barley production in this area. Another two-rowed malting barley, Ellice, is adapted to this region and represented 12% of the malting barley area of Manitoba in 1989.

1: Estimate of Total Barley Production in the Prairie Provinces[1]
Comparison of 1989 and 1988 Data

	Seeded Area		Yield		Production	
	1988	1989	1988	1989	1988	1989
	(thousand hectares)		(tonnes/hectare)		(thousand tonnes)	
Manitoba	567.0	647.0	1.92	2.42	1 089.0	1 568.0
Saskatchewan	1 234.0	1 497.0	1.69	1.99	2 090.0	2 983.0
Alberta	1 902.0	2 104.0	3.06	2.90	5 813.0	6 096.0
Prairie Provinces	**3 703.0**	**4 248.0**	**2.43**	**2.51**	**8 992.0**	**10 647.0**

[1] September Estimate of Production of Principal Field Crops, Canada, 1989
Field Crop Reporting Series, No. 7, Statistics Canada

2: Estimates of Distribution of Malting Barley and Feed Barley in the Prairie Provinces[1]
Comparison of 1989 and 1988 Data

	% Malting Varieties		% Feed Varieties	
	1988	1989	1988	1989
Manitoba	58.1	57.9	41.9	42.1
Saskatchewan	88.9	90.2	11.1	9.8
Alberta	55.7	58.7	44.3	41.3
Prairie Provinces	**66.5**	**69.6**	**33.5**	**30.4**

[1] *Prairie Grain Variety Survey*, 1988 and 1989, Prairie Pools Inc.

3: Estimate of Malting Barley Production in the Prairie Provinces[1]
Comparison of 1989 and 1988 Data

	Seeded Area		Production	
	1988	1989	1988	1989
	(thousand hectares)		(thousand tonnes)	
Manitoba	329.4	374.6	632.4	906.5
Saskatchewan	1 097.0	1 350.3	1 853.9	2 687.1
Alberta	1 059.4	1 235.0	3 241.8	3 581.5
Prairie Provinces	**2 485.8**	**2 959.9**	**5 728.1**	**7 175.1**

[1] based on data presented in Tables 1 and 2.

4: Distribution of Malting Varieties as a Percent of Malting Barley Production[1]

	Alberta		Saskatchewan		Manitoba		Prairie Provinces	
Crop Year	1988	1989	1988	1989	1988	1989	1988	1989
Thousand Tonnes[2]	3 241.8	3 581.5	1 853.9	2 687.1	632.4	906.5	5 728.1	7 175.1
Six -rowed Varieties (%)	**24.8**	**25.2**	**28.9**	**28.0**	**86.4**	**85.2**	**34.2**	**33.9**
Argyle	7.3	7.9	5.6	6.6	35.8	42.3	10.1	11.6
Bonanza	13.8	14.0	21.4	20.5	37.5	33.8	20.0	19.4
Conquest	3.7	3.3	1.9	0.9	13.1	9.1	4.1	2.9
Two-rowed Varieties (%)	**75.2**	**74.8**	**71.1**	**72.0**	**13.6**	**14.8**	**65.8**	**66.1**
Betzes	3.1	0	1.0	0.9	0	0	1.8	0.4
Klages	11.5	8.8	9.0	5.9	0	0	9.0	6.4
Harrington	59.5	63.2	58.6	62.3	0	0	51.8	55.0
Ellice	0.2	0.6	2.5	2.9	11.7	11.8	2.6	3.0
Others	0.9	2.2	0	0	1.9	3.0	0.6	1.3

[1] from data provided in *Prairie Grain Variety Survey*, 1988 and 1989, Prairie Pools Inc.
[2] estimates in Table 3

Sampling and General Crop Quality

This year's harvest survey is based on 5 108 samples of malting barley selected by domestic malting companies for potential purchase. Barley selectors for these companies composited samples by variety (or varieties) and by province (or provinces) and forwarded these composites to the Grain Research Laboratory on a regular basis from the beginning of harvest to the end of September 1989, at which time the survey was discontinued. Details as to numbers and source of samples received are given in Table 5. Each sample selected for purchase by maltsters may result in delivery of one railway carlot of approximately 90 tonnes of barley.

Alberta is usually the major province for producing malting barley in Western Canada. However, the frequent rains in August and September severely delayed harvesting in central and northern Alberta, resulting in severe weather-staining and sprouting damage. As a result, much of the selection of two-rowed malting barley has been in Saskatchewan (Table 4), and it is possible that good two-rowed barley will be in short supply as the year progresses.

Dry conditions in Saskatchewan and Manitoba during July affected grain filling in both two-rowed and six-rowed varieties; therefore, some of the malting barley tends to be thin with high protein content. Good six-rowed barley is already in demand and will be in short supply for the remainder of the 1989-90 crop year.

5: Origin and Distribution of 1989 Harvest Survey Samples (for each varietal composite)

	Provincial Origin				
Variety	Alberta	Saskatchewan	Manitoba	Saskatchewan & Manitoba	Prairie Provinces
Bonanza	150	52	88	291	581
Bonanza/Argyle	-	-	142	-	142
Argyle	50	-	-	275	325
Total 6-rowed	**200**	**52**	**230**	**566**	**1 048**
Harrington	1 175	2 597	45	-	3 817
Klages	-	153	-	-	153
Ellice	-	-	-	90	90
Total 2-rowed	**1 175**	**2 750**	**45**	**90**	**4 060**
Total Selections	**1 375**	**2 802**	**275**	**656**	**5 108**

Malting Quality Data

Harrington

Quality data for this two-rowed selection are given in Table 6. Although kernel weight is a little low, kernel plumpness is generally satisfactory. Barley protein content values are within acceptable limits, and germination characteristics are good.

Malts prepared from composite samples of Harrington barley are over-modified as evidenced by low fine-grind/coarse-grind extract differences and by high ratios of soluble to total protein in wort. Coarse-grind extract may be somewhat reduced for this year's crop, but comparative data from previous crops are not available for direct comparisons. Harrington has high amylolytic activities and these characteristics are confirmed in composite samples of the 1989 crop.

Klages and Ellice

Composite samples of these two-rowed varieties were represented by considerably fewer selections (Table 7) as might be expected from the area seeded to each of these varieties. Klages tends to have reduced kernel plumpness compared with Harrington and Ellice, and this is exhibited in the samples of the current crop. Amylolytic activities for Klages are lower also.

Quality data (Table 7) show that malts prepared from Ellice tend to have lower extract yield and alpha-amylase activity compared with Harrington. Other malt quality characteristics for Klages and Ellice are very similar.

Bonanza

Table 8 provides quality data for composite samples of Bonanza barley, a six-rowed selection. Samples from Alberta have low germination energy and high water-sensitivity, and some selections from Saskatchewan and Manitoba also have high water-sensitivity. Barley selectors will be concerned about these germination characteristics as purchases of Bonanza are considered in ongoing selections.

Malt quality characteristics of Bonanza are generally good. Although endosperm modification as shown by low F/C difference is good, extract yields may be somewhat reduced. Protein modification and wort-soluble protein are much lower for malts prepared from Bonanza compared with malts prepared from Harrington but are within normal ranges for Bonanza barley.

Argyle and Bonanza/Argyle

Some samples of Argyle barley from Alberta exhibit some water-sensitivity (Table 9), and this will be of concern in selections of this six-rowed variety. Otherwise, malt quality characteristics of Argyle and blends of Bonanza/Argyle are generally satisfactory. Argyle tends to have higher diastatic power compared with Bonanza, and this characteristic is confirmed by these data.

6: Quality Data for 1989 Harvest Survey Composite Samples of Malting Barley

Variety	Harrington			
Origin of Selected Samples	Alberta	Saskatchewan	Manitoba	Prairie Provinces
No. of Selections	1 175	2 597	45	3 817
BARLEY				
Physical Characteristics				
1000 Kernel Weight, g	39.1	38.0	39.7	38.4
Heavy Grade, %	89.1	88.6	91.1	88.8
Intermediate Grade, %	9.2	9.8	7.2	9.6
Thin Grade, %	1.7	1.6	1.7	1.6
Chemical Analysis				
Moisture Content, %	11.2	11.7	11.0	11.5
Protein Content, %	12.3	12.2	12.2	12.2
Germination Characteristics				
Germination Energy, %	97	99	100	98
Water Sensitivity, %	6	4	3	5
MALT				
Malt Yield, %	88.6	88.5	88.6	88.5
Roots, %	3.7	4.3	3.7	4.1
Moisture Content, %	4.4	4.3	4.4	4.3
WORT				
Fine Grind Extract, %	79.6	78.8	79.6	79.1
Coarse Grind Extract, %	78.9	78.2	78.9	78.4
F/C Difference, %	0.7	0.6	0.7	0.7
Soluble Protein, %	5.46	5.49	5.46	5.48
Ratio S/T, %	49.2	47.6	49.2	48.1
Diastatic Power, °L	176	160	176	165
Alpha-amylase, DU	70.3	63.9	70.3	65.9

7: Quality Data for 1989 Harvest Survey Composite Samples of Malting Barley

Variety	Klages	Ellice
Origin of Selected Samples	Saskatchewan	Saskatchewan/Manitoba
No. of Selections	153	90
BARLEY		
Physical Characteristics		
1000 Kernel Weight, g	40.7	37.8
Heavy Grade, %	86.4	88.7
Intermediate Grade, %	11.9	9.9
Thin Grade, %	1.7	1.4
Chemical Analysis		
Moisture Content, %	11.7	10.8
Protein Content, %	11.9	12.6
Germination Characteristics		
Germination Energy, %	96	98
Water Sensitivity, %	5	5
MALT		
Malt Yield, %	91.9	87.9
Roots, %	2.4	4.1
Moisture Content, %	4.3	4.3
WORT		
Fine Grind Extract, %	79.3	77.9
Coarse Grind Extract, %	78.5	77.2
F/C Difference, %	0.8	0.7
Soluble Protein, %	4.96	5.62
Ratio S/T, %	44.3	47.5
Diastatic Power, °L	136	162
Alpha-amylase, DU	55.9	58.8

8: Quality Data for 1989 Harvest Survey Composite Samples of Malting Barley

Variety	Bonanza				
Origin of Selected Samples	Alberta	Saskatchewan	Saskatchewan & Manitoba	Manitoba	Prairie Provinces
No. of Selections	150	52	291	88	581
BARLEY					
Physical Characteristics					
1000 Kernel Weight, g	33.6	33.8	33.4	34.0	33.6
Heavy Grade, %	74.8	77.4	78.3	82.2	77.9
Intermediate Grade, %	18.6	19.9	18.1	15.6	18.0
Thin Grade, %	6.6	2.7	3.6	2.2	4.1
Chemical Analysis					
Moisture Content, %	10.7	11.4	11.5	11.3	11.3
Protein Content, %	12.3	11.9	13.0	13.0	12.7
Germination Characteristics					
Germination Energy, %	85	100	98	100	95
Water Sensitivity, %	30	2	23	2	20
MALT					
Malt Yield, %	89.6	87.6	87.9	88.6	88.4
Roots, %	5.1	4.3	4.0	5.6	4.6
Moisture Content, %	4.7	4.4	4.2	4.5	4.4
WORT					
Fine Grind Extract, %	76.8	77.3	76.5	76.5	76.7
Coarse Grind Extract, %	75.7	76.8	75.8	76.0	75.9
F/C Difference, %	1.1	0.5	0.7	0.5	0.8
Soluble Protein, %	4.83	4.99	5.06	5.12	5.00
Ratio S/T, %	41.0	44.2	41.4	42.7	41.7
Diastatic Power, °L	162	151	163	200	167
Alpha-amylase, DU	54.4	51.4	51.3	61.0	53.6

9: Quality Data for 1989 Harvest Survey Composite Samples of Malting Barley

Variety	Argyle			Bonanza/ Argyle
Origin of Selected Samples	Alberta	Saskatchewan & Manitoba	Prairie Provinces	Manitoba
No. of Selections	50	275	325	142
BARLEY				
Physical Characteristics				
1000 Kernel Weight, g	32.5	35.6	35.1	32.9
Heavy Grade, %	76.5	79.2	78.8	77.5
Intermediate Grade, %	17.8	17.3	17.4	19.2
Thin Grade, %	5.7	3.5	3.8	3.3
Chemical Analysis				
Moisture Content, %	10.3	11.1	11.0	10.7
Protein Content, %	12.3	12.7	12.7	12.8
Germination Characteristics				
Germination Energy, %	97	98	98	100
Water Sensitivity, %	12	0	2	2
MALT				
Malt Yield, %	88.6	88.6	88.6	87.9
Roots, %	4.0	4.0	4.0	4.7
Moisture Content, %	4.3	4.3	4.3	4.4
WORT				
Fine Grind Extract, %	77.0	77.0	77.0	76.2
Coarse Grind Extract, %	76.1	76.1	76.1	75.0
F/C Difference, %	0.9	0.9	0.9	1.2
Soluble Protein, %	4.68	4.68	4.68	5.14
Ratio S/T, %	39.7	39.7	39.7	42.2
Diastatic Power, °L	163	188	184	195
Alpha-amylase, DU	53.9	58.7	57.9	57.2

Methods

Notes on the methods used at the Grain Research Laboratory are given below. Unless otherwise specified, analytical results for barley and malt are reported on a dry weight basis. The ASBC methods cited are those of the American Society of Brewing Chemists, Seventh Edition, 1976.

Dockage and Assortment. All samples are passed through a Carter Dockage Tester equipped with a No. 6 riddle to remove foreign material and with 6/64" and 5/64" screens to assort the barley. Heavy Grade barley is the material retained on a 6/64" (2.38 mm) screen. Intermediate Grade is barley retained on a 5/64" (1.98 mm) screen, and Thin Grade is the barley that passes through the 5/64" screen.

Weight per Thousand Kernels. A small sample of dockage-free, Heavy Grade barley is hand-picked to remove any residual foreign material and broken kernels. The number of kernels in a 20 g subsample of this cleaned material is then counted.

Moisture Content of Barley (ASBC) is determined on a ground sample at 130°C for 1 h in a forced draft oven.

Moisture Content of Malt (ASBC) is determined on a ground sample at 104°C for 3 h in a convection oven.

Protein Content (N x 6.25) is determined on Heavy Grade barley by the Kjeldahl method as modified by Williams, *Journal of the Science of Food of Agriculture* 24:343, 1973.

Germination Energy is determined by placing 100 kernels of Heavy Grade barley on a disc of Whatman #2 filter paper in a 9.0 cm petri dish and adding 4.0 mL of de-ionized water. Samples are kept in the dark at room temperature. Germinated kernels are counted and discarded after 72 h, and a final germination count is determined after a further 48 h.

Water Sensitivity is determined exactly as described for germination energy, except that 8.0 mL of de-ionized water is added to each petri dish. Water sensitivity is defined as the difference between the number of kernels germinated with 4.0 mL of water and 8.0 mL of water, multiplied by 100.

Malting Conditions. A GRL micro-malting unit designed to malt eight 500-g samples of Heavy Grade barley is used for these studies. Samples are steeped for 48 h at 13°C using alternate cycles of wet steeping and dry steeping. Germination continues for a further 5 days at 13°C in a humidified growth chamber with samples enclosed in stainless steel cages mounted on a rotating drum. Green malts are transferred to a kilning unit and dried to 4% moisture during 48 h of heating at incremental temperatures of 25°C, 50°C, 60°C and 80°C.

Malt Mills (ASBC). Fine-grind malt is prepared with a Miag-Seck laboratory mill for fine grinding (cone type, 300 rpm). Coarse-grind malt is prepared with a Miag-Seck laboratory mill for coarse grinding (roller type, 150 rpm).

Fine-Grind and Coarse-Grind Extracts (ASBC) are prepared using a Brewing Research Foundation (BRF) mash bath and the Congress mashing procedure from 45°C to 70°C. Specific gravities are determined at 20°C with an Anton Paar DMA 55 digital density meter (LaBerge, *Journal of the American Society of Brewing Chemists* 37:105, 1979).

Wort-Soluble Protein (ASBC) is determined by the Kjeldahl method as modified by Williams, *Journal of the Science of Food of Agriculture* 24:343, 1973.

Diastatic Power (ASBC) is determined using the ferricyanide assay for reducing sugars.

Alpha-Amylase Activity is determined using beta-limit dextrin, prepared from waxy maize starch, as substrate (Briggs, *Journal of the Institute of Brewing* 67:427, 1961). Alpha-amylase activity determined by this method is converted to Dextrinizing Units (DU) using regression equations relating this method to the official ASBC procedure.

Acknowledgements

The Grain Research Laboratory acknowledges the cooperation of domestic malt companies for providing composite samples of varietal selections of malting barley. Special thanks are extended to Mr. Jack Tye, Canada Malting Co., Ltd., Winnipeg, Mr. Bob Sutton, Canada Malting Co., Ltd., Calgary, and Mr. Al Morris, Dominion Malting Limited, Winnipeg. The Weather and Crop Surveillance Section of the Canadian Wheat Board is acknowledged for providing the synopsis of weather and growing conditions affecting the quality of malting barley. The assistance of the Brewing and Malting Barley Research Institute, Winnipeg, in providing the cover photograph is also gratefully acknowledged.